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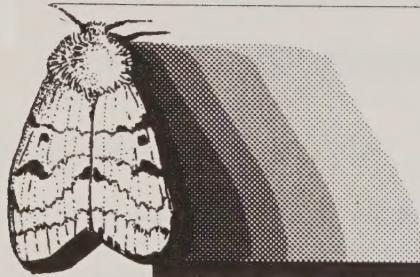
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# GYPSY MOTH NEWS



United States  
Department of  
Agriculture



NORTHEASTERN AREA  
State and Private Forestry

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Address correspondence to the Editor.

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## FROM THE EDITOR

Where does the money come from?

Gypsy moth suppression (spraying) is conducted by State agencies for private landowners and by the USDA Forest Service on both National Forest and other Federal lands (such as the National Park lands, Army Corps of Engineer Recreation sites, and Department of Defense sites).

Last year, Northeastern Area State and Private Forestry provided \$6,240,000 to 9 States involving 10 agencies as the Federal share of gypsy moth suppression. An additional \$649,980 went to the Allegheny and the Huron-Manistee National Forests. Other Federal agencies in the northeast including the National Park Service and the Fish and Wildlife Service received \$197,559 for gypsy moth suppression.

This money was appropriated by Congress through the regular appropriation process. However, in 1993, an Emergency Pest Suppression Funding process has been instituted. These Emergency funds are an authorization rather than an appropriation. For 1993, the Forest Service is looking towards this source for part of the funding needs for cooperative and National Forest gypsy moth suppression.

In this issue, several reports of *Entomophaga maimaiga* are presented so that you can keep up with the "*maimaiga mania*" taking place. In case *Entomophaga maimaiga* is a new addition to your vocabulary, there are several things you should know before you start using it in casual conversation:

- *E. maimaiga* is a potent fungal pathogen of the gypsy moth.
- It is an important natural mortality factor of gypsy moth in Japan.
- Experts think the fungus has been present in this country since the early 1900's.
- It cannot be grown on Chia pets on your windowsill.

- Since about 1989, reports of an increase in the occurrence of *E. maimaiga* have been making their way to the scientific literature.

*E. maimaiga* and the naturally occurring virus both had an impact upon larval populations last year resulting in lower than expected acreages to be treated in 1993. If the trend continues, nature may have provided the "silver bullet" we were looking for to keep gypsy moth populations low enough to eliminate or at least reduce the need for suppression.

--DBT

## LETTER TO THE EDITOR

Dr. R. F. DeBoo with the Ministry of Forests in British Columbia is asking for input:

"I am preparing a 'Plant Health Emergency Manual' for the British Columbia Plant Protection Advisory Council. Gypsy moth is the model problem. Does anyone out there have experience with a manual of this sort? Are there signed agreements (State/Federal) regarding roles, responsibility, funding, surveys, R&D, etc?

If you are able to help Dr. Deboo in his pursuit of the above information, please give him a call or write to:

Dr. R. F. DeBoo  
Province of British Columbia  
Ministry of Forests  
c/o Pacific Forestry Centre  
Forestry Canada  
506 W. Burnside Road  
Victoria, British Columbia V8Z 1M5

Phone: 604-363-0751

# **ENTOMOPHAGA MAIMAIGA AND GYPSY MOTH ON THE NATIONAL FORESTS IN VIRGINIA**

**Jeff Witcosky**  
**USDA Forest Service**  
**George Washington National Forest**  
**P.O. Box 233**  
**Harrisonburg, VA 22801**

A relatively new natural enemy, *Entomophaga maimaiga*, is established and spreading throughout gypsy moth populations in the eastern United States. This fungal pathogen is causing dramatic reductions in gypsy moth populations across a broad range of densities, including relatively low (100 egg masses per acre) population levels. Outbreaks of the fungus are favored by cool, wet conditions in May and June. Although all instars are susceptible, the fungus typically becomes evident when fourth instar gypsy moth larvae begin to move up and down the boles of infested trees. It is at this time that one observes dead caterpillars assuming a characteristic head-down, stretched-out posture on the boles of trees. Because fungal populations tend to develop and intensify during the 4th-6th instars, populations of gypsy moth may collapse before any severe defoliation can develop.

In 1991, the George Washington (GWNF) and the Jefferson (JNF) National Forests participated with research scientists Dr. Ann Hajek of the Boyce Thompson Institute and Dr. Joe Elkinton of the University of Massachusetts in a project to evaluate a procedure for introducing *E. maimaiga* into forests infested with gypsy moth and to study how this pathogen spreads in gypsy moth populations under natural conditions.

During 1991 and 1992, *E. maimaiga* was released at a total of 14 sites on the GWNF and JNF. Gypsy moth egg masses at these sites ranged from 100-500 egg masses per acre. Some release sites were isolated from the main center of defoliating gypsy moth populations while others were located near the edge of these populations. Following release, the fungus was recovered from dying caterpillars at all 14 sites. Also, in 1992 the fungus reappeared in gypsy moth

populations at the 1991 release sites indicating that it had become established at these locations.

The average rate of spread of *E. maimaiga* in 1991 was estimated to be about 350 meters from a release site. Assuming that spread was uniform in all directions, caterpillars within an area of approximately 90 acres around a release site were affected by the fungus that year. At the 1992 release sites, the fungus spread to distances greater than 1 kilometer from the point of release.

Several aspects of the *E. maimaiga*-gypsy moth interaction are of interest. Weather conditions in 1992 were so favorable that the fungus developed to, and remained at, epidemic levels throughout late May and June while the last three larval instars were developing; caterpillar populations quickly collapsed in many affected stands. As a result, the GWNF reported considerably less acreage in the severely defoliated category (>50 percent defoliation) in 1992, relative to 1990-91, and noted a commensurate increase in acreage in the moderately defoliated category (30-50 percent defoliation). The GWNF had anticipated that approximately 170,000 acres of the forest would be severely defoliated in 1992; the GWNF actually reported about 94,000 acres that year. The difference between these two figures represents the estimated effect the fungus had on gypsy moth populations. Egg mass densities declined dramatically in many affected areas; this should lead to reduced defoliation on the forest this coming year as well.

A second aspect of interest is that *E. maimaiga* may cause impacts at relatively low densities of gypsy moth. Isolated populations with less than 70 egg masses per acre were affected by the fungus in 1992. At Hunting Creek on the JNF, an isolated population dropped from 320 egg masses per acre to approximately 8 egg masses per acre in 2 years.

Finally, *E. maimaiga* also appears to have spread into portions of the GWNF from affected areas to the north. During a mid-June, forest-wide survey of gypsy moth populations on GWNF lands, *E. maimaiga* was discovered in every population sampled. Although we released *E. maimaiga* at a number of sites across the forest, fungus-killed caterpillars were found at great distances from any of these locations. This suggests that a major movement or movements of infective spores (conidia) occurred

from affected areas to the north. Infective spores can spread on the wind and this is currently a topic of research for Drs. Hajek and Elkinton.

## GYPSY MOTH FUNGUS HITS LATE INSTARS IN NEW JERSEY

John D. Kegg  
New Jersey Department of Agriculture  
Division of Plant Industry  
Trenton, NJ 08625

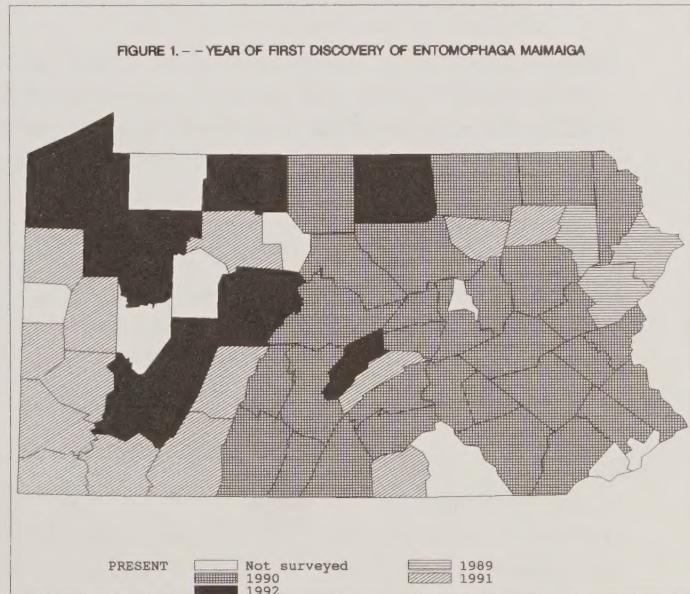
The gypsy moth fungus, *Entomophaga maimaiga*, still continues to have a major impact in reducing gypsy moth numbers. As if on cue, the disease rapidly moved through the late instar larval populations in June with such devastation that few caterpillars ever made it to the pupal and adult stages. The rainy, humid weather occurring at that time definitely enhanced the fungus. The result was that in many cases, where defoliation would have been near 100 percent, the caterpillars succumbed to the fungus, with defoliation stopping at about the 50-60 percent level. This condition was a widespread phenomenon in the outbreak in the Hamburg and Green Pond Mountains extending from Milton to Vernon.

In the untreated areas of High Point State Park, where gypsy moth egg counts were over 30,000 per acre, severe defoliation occurred before the caterpillars reached their last instar. However, the larval fungus, although not in time to prevent the 100 percent defoliation, did kill fifth instar larvae in large numbers and few made it to the adult stage. The late instar larvae crawl into the leaf litter, and puts them in direct contact with the disease spores in the soil. This is the main reason why the fungus is so devastating to late instar larvae. Based on these observations, the major outbreaks in northwestern New Jersey should not reappear in the same forests next year.

## A SUMMARY OF *ENTOMOPHAGA MAIMAIGA* ACTIVITY IN PENNSYLVANIA

Edward E. Simons  
Pennsylvania Department of  
Environmental Resources  
Bureau of Forestry  
Middletown, PA 17057-5080

The fungus *E. maimaiga* was first found infecting gypsy moth caterpillars in three northeastern Pennsylvania counties in 1989. In 1990 the fungus was discovered in 30 additional counties of eastern and central Pennsylvania. Gypsy moths from 14 additional counties were found infected in 1991, including several in western Pennsylvania. The Pest Management Division participated in the introduction of spores in western Pennsylvania counties, and succeeded in establishing the disease at several locations that year. The fungus was found in 11 more counties of central and western Pennsylvania in 1992. We consider the fungus established throughout Pennsylvania, including the southern and western tier counties. (See Figure 1 for year of first discovery of *E. maimaiga* in Pennsylvania counties.)



The first evidence of fungus activity in 1992 was in northeastern Pennsylvania where young caterpillars were dying and producing conidia the first week of June. Fungus caused mortality occurred among larvae collected weekly through mid-July or until live caterpillars could no longer be found. The fungus, in combination with virus, caused a collapse of the gypsy moth in northeast Pennsylvania. In western Pennsylvania, population collapses apparently were caused more by virus than *E. maimaiga*. In northcentral Pennsylvania gypsy moth populations remained relatively healthy until July. Despite finding the fungus in an additional county, it is believed the fungus did not have a significant role in the population collapse in northcentral Pennsylvania. In the ridge and valley province of central Pennsylvania and the mountains of southcentral Pennsylvania the fungus was active in June and caused population collapses. In this area, our Division has collected about 4-5 kilos of cadavers containing resting spores which will be processed for redistribution in 1993.

For more information, contact Ed Simons at 717-948-3941.

## AIPM FUNDED COOPERATIVE AGREEMENTS: *ENTOMOPHAGA MAIMAIGA*

**Richard Reardon  
USDA Forest Service  
AIPM Project  
180 Canfield Street  
Morgantown, WV 26505**

Since *Entomophaga maimaiga* (EM) was found causing a natural epidemic in dense populations of gypsy moth throughout the Northeastern United States in 1989, the Forest Service has provided funds to investigate biology and population dynamics of the fungus. The following studies were undertaken:

1. Introduction and spread of EM in AIPM project area - University of Massachusetts; 1990, 1991 and 1992.
2. Introduction and spread of EM outside AIPM project area - Boyce Thompson Institute; 1990-1991 and 1992.
3. Competition between EM and NPV - University of Massachusetts; 1991, 1992-1993.
4. Impact of EM on non-target Lepidoptera - West Virginia University; 1992-1993.
5. Impact of EM on non-target Lepidoptera (laboratory) - Boyce Thompson; 1992-1993.

Copies of these cooperative agreements as well as final reports/draft-manuscripts for those cooperative agreements terminating on or before December 1992 are available by contacting Richard Reardon (304-285-1566).

# **FIELD IDENTIFICATION OF THE GYPSY MOTH FUNGUS, *ENTOMOPHAGA MAIMAIGA***

**Ann E. Hayek**

**Boyce Thompson Institute  
for Plant Research  
Ithaca, NY 14850  
and**

**Amy L. Snyder  
USDA Forest Service  
Forest Health Protection  
P.O. Box 640  
Durham, NH 03824**

The gypsy moth fungus can kill large numbers of gypsy moth caterpillars (larvae) during late developmental stages (instars). The dead larvae remain attached to the surfaces where they died (often lower tree trunks) for some time. These fungal-killed larvae are often confused with cadavers of larvae killed by another important disease of the gypsy moth, the gypsy moth virus (NPV).

Cadavers of larvae killed by the gypsy moth fungus and virus can be roughly differentiated in the field. The best criteria for field identification of cadavers killed by the gypsy moth fungus are:

- body position,
- dryness of body, and
- proleg position.

Bodies of dead late instar larvae are frequently attached vertically with heads downward. Cadavers of larvae dying from this disease are often covered with fungal growth, but only for a brief time after larval death. Occasionally, some spores remain attached to larval hairs. Cadavers frequently become withered and brittle as they remain hanging after the larva's death. Fungal-killed larvae sometimes die with abdominal prolegs at a 90 degree angle to the body (See Figure 1).

Presence of spores on cadaver hairs is variable and easy to misidentify in the field.

There is considerable variability in cadaver symptoms so microscopic examination is necessary for more precise determination of the cause of death.

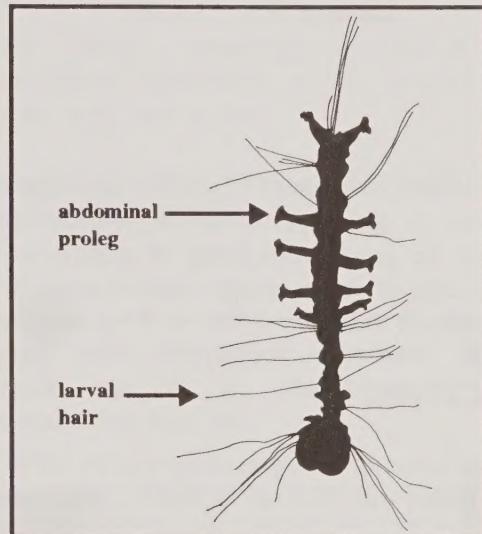


Figure 1

This article is now available as a USDA Forest Service Natural Enemies Fact Sheet, NA-PR-02-92. Contact Amy Snyder for additional copies of the Fact Sheet.

# **SLOW-THE-SPREAD PILOT PROJECT**

**Robert Wolfe**  
**USDA Forest Service**  
**Forest Health Protection**  
**5 Radnor Corporate Center**  
**Radnor, PA 19087**

## **GOAL**

In cooperation with other Federal and State agencies, implement an operational effort to slow the spread (STS) of the gypsy moth along all portions of the leading edge of the generally infested areas in the eastern United States.

## **OBJECTIVES**

Using the latest technologies developed by AIPM and Forest Insect and Disease Research, implement a large scale, multi-year pilot project to evaluate the technical, operational, economic and environmental feasibility of slowing the spread of the gypsy moth along the leading edge in selected areas of North Carolina, Virginia, West Virginia, and Michigan.

Based on the results of the pilot project, recommend for or against operational implementation of the slow-the-spread concept.

## **ACCOMPLISHMENTS (1992)**

Jose Negron, was selected as acting STS Project Manager until a permanent project manager could be recruited.

A Steering Committee was formed that is responsible for project implementation and decisionmaking. The acting Project Manager serves as the head of the Steering Committee. This Committee consists of one management person from each involved State Agency, Animal and Plant Health Inspection Service (APHIS), National Forest System (NFS), National Park Service (NPS), Region 8 (R8), Forest Pest Management (FPM), Northeastern Area Forest Health Protection (NA, FHP) and Virginia Polytechnic Institute (VPI).

A Technical Committee was formed to make technical recommendations associated with the project to the Steering Committee. This committee is made up of technical authorities from FS Research, APHIS, NFS, NPS, FPM R8, FHP NA, State Agencies and selected Universities.

Monitoring of gypsy moth populations in potential project areas of North Carolina, Virginia and West Virginia was implemented. Monitoring data from the three potential project areas was displayed geographically and spatially as an aid to selection of the final slow the spread project areas. This information was reviewed by the Technical Committee and recommendations were made to the Steering Committee for final implementation. Based on the monitoring data final, project areas were selected in North Carolina, Virginia, and West Virginia.

A contract for the chemical formulation of 10-thousand-acre equivalents of gypsy moth pheromone was executed. The pheromone will be used in the formulation of flakes applied aerially as a confusant of male moths in lightly infested areas in 1993 and subsequent years.

## **PLANS (1993)**

Based on recommendations from the Technical Committee, intensive monitoring grids will be installed in 1993 to delimit suspected infestations for intervention in 1994.

Technical Committee recommendations were made for areas needing intervention in 1993. Pheromone flakes will be utilized in the selected areas.

Operating budgets of STS Project cooperators were reviewed and finalized to comply with the funding allocated for 1993.

A potential project area in the Upper Peninsula of Michigan was identified for systematic population monitoring in 1993. Based on the results of the monitoring and active participation by State and Federal cooperators, an additional project area may be initiated in Michigan in 1994.

For more information about the Slow the Spread Project, contact Jose Negron at 704-257-4843.

## GYPSY MOTH DEFOLIATION 1992

## PUBLICATIONS

<b>State</b>	<b>Acreage</b>
Connecticut	31,637
Delaware	4,943
Massachusetts	123,794
Maryland	38,704
Maine	278,485
Michigan	712,227
New Hampshire	182,575
New Jersey	165,960
New York	60,022
Ohio	1,130
Pennsylvania	641,445
Rhode Island	0
Vermont	83
Virginia	748,000
West Virginia	67,718
Total	3,056,723

### New Publications:

**Silvicultural guidelines for forest stands threatened by the gypsy moth** by K. Gottschalk. 1993. USDA Forest Service NE Forest Exp. Station, Gen. Tech. Rpt NE-171, 49 p.

*This report summarizes ecological and silvicultural information on the interaction of gypsy moth and its host.*

For copies of this publication, contact Kurt Gottschalk at 304-285-1598.

**Photographic guide to crown condition of oaks: Use for gypsy moth silvicultural treatments** by K. Gottschalk and W. R. MacFarlane. 1992. Northeastern For. Exp. Sta.

*Color photographs are provided as guides to assessing corwn condition and the various factors involved in assigning corwn conditions are discussed.*

### Old Publication:

**Discovery of Entomophaga maimaiga in North American gypsy moth** by T. G. Andreadis and R. Weseloh. 1990. In Proc. Nat'l Acad. Sci. 87(2461-2465).

Andreadis can be reached at the Connecticut Agricultural Experiment Station, P. O. Box 1106, New Haven, CT 06504.

# GYPSY MOTH MANAGEMENT OPERATIONS UPDATE

## Aeronautical Decision Making for Natural Resource Pilots

**Bob Adams**  
**USDA Forest Service**  
**Forest Health Protection**  
**5 Radnor Corporate Center**  
**Radnor, PA 19087**

The following is a review of a report entitled, Aeronautical Decision Making for Natural Resource Pilots by F. A. Fuchs, USDA Forest Service, July 1989, TEO1P12<sup>11</sup>.

"Aeronautical Decision Making (ADM) is a systematic approach to the mental process used by aircraft pilots to consistently determine the best course of action in response to a given set of conditions," as defined by the Federal Aviation Administration (FAA) in Advisory Circular (AC) No. 60-22, 12/13/91<sup>12</sup>. Fred Fuchs, USDA Forest Service, adapted background information from this AC and several other papers in order to focus on similar problems faced by pilots in natural resource aviation. Fred's report and the AC and similar studies done in the U.S., Canada, and Australia all arrive at the conclusion that pilots who have received ADM training make fewer inflight errors than those that have not. Study of these reports and utilization of the self-tests that are included will enhance skills needed to operate an aircraft with an increased awareness of safety, especially in the hazardous low-level environment that we work in.

Fred examines a number of components necessary to make good judgement decisions regarding flight. His paper includes methods to identify the causes of stress in the flight environment and ways to resolve these causes. Risk management is also an important part of the process. It includes identification of five basic elements of any flight:

1. The Pilot (or crew)
2. The Aircraft
3. The Environment
4. The Operation (or mission)
5. The Situation

It is noted that "(T)he pilot has the **primary** controlling capability and responsibility for assessing the relative levels of risk in each element of the flight and effectively managing them in order to produce a safe outcome." Another way to step in the direction of good aeronautical decision making is to decide whether or not to conduct a particular flight. One way to reach a "go/no go" decision is to "Deal Yourself a Good Hand!"

If **The Situation** is the thumb on your hand, and each finger represents **The Pilot**, **The Aircraft**, **The Environment** and **The Operation** then a thumbs up for a "go" decision will be reached when all fingers represent positive inputs. For example, when aviation has been selected to accomplish a task, a "go" decision for a specific **situation** is reached when: we find that the **pilot** is qualified for the mission, is rested and is available; the **aircraft** is airworthy, the correct one for the task, is serviced and ready to go; the **environment** is appropriate for the flight, weather conditions are not limiting, weather at the departure point, enroute and at the arrival point meets expectations, density altitude can be accounted for, it is night or day as needed; the **operation** can be conducted efficiently and safely with the given pilot, aircraft and environmental conditions. If any of the "fingers" represent a negative, then the condition would be a thumbs down and changes would need to be made, or the flight not undertaken.

Stress is an important concept to consider in flying, much less our daily lives. Stress seems to have a positive effect on performance when it is moderate, or at an optimum level. However, if there is little or no stress regarding performance we tend to become bored and inattentive - or, if stress exceeds the optimum panic will set in and performance will degrade rapidly. Three classes of stressors are examined in flying: **physical** stressors are those

which are environmental - such as temperature, noise, vibration and other extremes that lead to discomfort; **physiological** stressors include fatigue, lack of physical fitness, sleep loss, missed meals, body functions and disease; **psychological** stressors relate to social and emotional factors related to life. A problem with flight is that often multiple decisions must be reached simultaneously, compounded by the stressors mentioned.

Coping with stress is covered by the authors in detail. Some thoughts include aspects of well-being, changing stressors, learning to cope, living with distress, withdrawing from a stressor, changing relationships to stressors, and even changing stressors. To mobilize stress as a positive force, at least three modes can be identified: deep muscle relaxation, progressive relaxation, and deep breathing exercises. All are learned stress relievers and can become habits in our daily lives.

To relieve stress and aid our memories, a number of checklists have been developed for use before, during and after flight. Physical, physiological and psychological stressors can also be relieved through the use of a checklist:

Like the **thumbs up** analogy, this checklist is easy to remember, comprehensive and likely to prevent an accident if a "no go" question arises regarding **The Pilot** component of **The Situation**. It is interesting to note that this review illustrates the idea that aeronautical decision making is not limited to pilots and aircraft! It is easily translated to the operation of any vehicles or machinery. Copies of the documents mentioned can be obtained by writing to:

<sup>1</sup> USDA Forest Service  
San Dimas T &  
444 E. Bonita Avenue  
San Dimas, CA 91773

<sup>2</sup> U.S. Department of Transportation  
General Services Section,  
M-443.2  
Washington, DC 20590

### ARE YOU FIT TO FLY? THE "TM SAFE" CHECKLIST

- I** llness? Do I have any symptoms?
- M** edication? Have I been taking prescription or over-the-counter drugs?
- S** tress? Am I under psychological pressure from the job? Do I have money, health, or family problems?
- A** lcohol? Have I had anything to drink in the last 8 hours? The last 24 hours? Do I have a hangover?
- F** atigue? How much time since my last flight? Did I sleep well last night and am I adequately rested?
- E** ating? Have I eaten enough of the proper foods to keep me adequately nourished during the entire flight?

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